

WHAT IS CLAIMED IS:

1. An optical signal amplifying triode comprising:  
a first semiconductor optical amplifier and a second semiconductor optical amplifier, each equipping an active layer formed of a pn junction and amplifying, performing wavelength conversion on, and then outputting an optical signal input therein;

a first optical input means, inputting a first input light of a first wavelength and a second input light of a second wavelength into the first semiconductor optical amplifier;

a first wavelength selector, selecting light of the second wavelength from among the light from the first semiconductor optical amplifier;

a second optical input means, inputting the light of second wavelength that has been selected by the first wavelength selector and a third input light of a third wavelength into the second semiconductor optical amplifier; and

a second wavelength selector, selecting output light of the third wavelength from among the light from the second semiconductor optical amplifier; and

being characterized in that the output light of the third wavelength is modulated in response to the intensity variation of either or both of the first input light of the first wavelength and the third input light of the third wavelength and the signal gain with respect to the third input light of the third wavelength is 2 or more.

2. The optical signal amplifying triode according to Claim 1, wherein the first input light of the first wavelength is modulated light, the second input light of the second wavelength is continuous light, the third input light of the third wavelength is control

light, and the output light of the third wavelength has a signal waveform, with which the modulation signal of the first input light is amplified, in the input interval of the control light.

3. The optical signal amplifying triode according to Claim 1 or 2, wherein the third wavelength is the same as the first wavelength.

4. The optical signal amplifying triode according to any of Claims 1 through 3, wherein the signal gain of the output light of the third wavelength with respect to the control light of the third wavelength is 10 or more.

5. The optical signal amplifying triode according to any of Claims 1 through 4, wherein the active layers of the semiconductor optical amplifiers are arranged from quantum wells, a strained-layer superlattice, or quantum dots.

6. The optical signal amplifying triode according to any of Claims 1 through 5, further comprising: a reflecting means, reflecting light that has been transmitted through the active layer of an above-mentioned semiconductor optical amplifier towards the semiconductor optical amplifier or the other semiconductor optical amplifier.

7. The optical signal amplifying triode according to any of Claims 1 through 6, wherein either or each of the first semiconductor optical amplifier and second semiconductor optical amplifier is equipped at one face thereof with a reflecting means that selectively reflects light, and the reflection means is optically coupled via a lens to either or each of the first semiconductor optical amplifier and second semiconductor optical amplifier.

8. The optical signal amplifying triode according to Claim 6 or 7, wherein the reflecting means comprises: a first wavelength selective mirror, which, among the light from the first semiconductor

optical amplifier, does not reflect the first input light of the first wavelength but reflects light of the second wavelength to the second semiconductor optical amplifier; and a second wavelength selective mirror, which, among the light from the second semiconductor optical amplifier, does not reflect the second input light of the first wavelength but reflects light of the third wavelength.

9. The optical signal amplifying triode according to Claim 6 or 7, wherein a wavelength selective filter, which does not transmit light of the first wavelength but transmits light of the second wavelength, is disposed between one end face of the first semiconductor optical amplifier and the reflecting means for reflecting light, and a wavelength selective filter, which does not transmit light of the second wavelength but transmits the wavelength of the control light, is disposed between one end face of the second semiconductor optical amplifier and the reflecting means for reflecting light.

10. The optical signal amplifying triode according to any of Claims 6 through 9, wherein the reflecting means functions as either or both of the first wavelength selector and second wavelength selector and the output light from an above-mentioned semiconductor optical amplifier is input into the other semiconductor optical amplifier by changing one or both of the incidence angle of the input light and the emission angle of the output light with respect to the reflecting means.

11. The optical signal amplifying triode according to any of Claims 1 through 6, 8, 9, and 10, wherein a plurality of sets of the first semiconductor optical amplifier and second semiconductor optical amplifier are disposed in optical waveguides formed on a

semiconductor substrate and these sets are integrated as a single chip.

12. The optical signal amplifying triode according to any of Claims 1 through 9, further comprising an optical circulator or a directional coupler, which makes input light be input into an above-mentioned semiconductor optical amplifier through one end face of the semiconductor optical amplifier and guides light, output from the semiconductor optical amplifier through the one end face, to an optical path that differs from that of the input light.

13. The optical signal amplifying triode according to any of Claims 1 through 12, wherein a wavelength selective mirror or wavelength selective filter that functions as the first wavelength selector or second wavelength selector is disposed inside an optical path and is arranged from any among the group consisting of a grating filter, with which the refractive index is varied periodically in the light propagation direction, a multilayer film filter, formed by layering a plurality of sets of layers that differ in refractive index, and a photonic crystal, having a photonic bandgap.

14. The optical signal amplifying triode according to any of Claims 1 through 13, wherein the optical signal amplifying triode makes up an optical NAND gate, an optical NOR gate, an optical flip-flop circuit, or an optical operational amplifier.

15. The optical signal amplifying triode according to any of Claims 1 through 14, wherein the second wavelength selector selects, from among the light output from the second semiconductor optical amplifier element, an output light of the third wavelength that corresponds to the wavelength of the control light and distributes the output light of the third wavelength among a plurality of optical transmission paths in accordance with the wavelength of the output

light of the third wavelength.

16. An optical signal transfer method of transferring an optical signal train, which has been transmitted via a predetermined transmission path, to transmission paths, among a plurality of transmission paths, that correspond to routing information contained in the optical signal, the optical signal transfer method comprising:

an input step of inputting the optical signal train, to which the routing information have been applied, to the main optical signal amplifying triode unit;

a wavelength conversion step of supplying control light of wavelengths, corresponding to signals indicating the routing information, to the main optical signal amplifying triode unit, and making optical signals of the wavelengths of the control light be output from the main optical signal amplifying triode unit; and

an optical distribution step of inputting the optical signals, output from the main optical signal amplifying triode unit, into an optical distributor and distributing the optical signals according to their wavelengths among the plurality of optical transmission paths connected to the optical distributor.

17. The optical signal transfer method according to Claim 16, wherein in the wavelength conversion step, amplitude modulation using the control light is applied to the optical signals, output from the main optical signal amplifying triode unit, to add new routing information to the optical signals.

18. The optical signal transfer method according to Claim 16 or 17, wherein the optical signal train is amplitude modulated at a modulation degree of no more than 90%.

19. An optical signal relay device, which, among optical signal transmission networks, transfers an optical signal train, having

routing information added thereto by amplitude modulation, from one network to transmission paths, among the transmission paths of another network, that correspond to the routing information contained in the optical signal, comprising:

- a control light generator, generating, based on the amplitude modulation signals of the optical signal train, control light of wavelengths corresponding to the destinations indicated by the amplitude modulation signals;

- a main optical signal amplifying triode unit, converting the optical signal train into an optical signal of the wavelengths of the control light; and

- an optical distributor, distributing the optical signal, output from the main optical signal amplifying triode unit, among a plurality of optical transmission paths in accordance with the wavelengths of the optical signal.

20. The optical signal relay device according to Claim 19, further comprising an electronic controller or an all-optical controller, which, in accordance with the amplitude modulation signals contained in the optical signal, makes control light of wavelengths, which are in accordance with the routing information indicated by the amplitude modulation signals, be generated from the control light generator.

21. The optical signal relay device according to Claim 20, further comprising:

- an optical splitter, branching a portion of the optical signal;

- a photoelectrical signal converter, converting the optical signal branched by the optical splitter to an electrical signal and supplying the electrical signal to the electronic controller; and

an optical delay element, disposed at the downstream side of the optical splitter and delaying the optical signal that is to be input into the main optical signal amplifying triode unit upon passage through optical splitter; and

wherein the electronic controller extracts the amplitude modulation signals contained in the optical signal and makes control light of wavelengths, which are in accordance with the routing information indicated by the amplitude modulation signals, be generated from the control light generator.

22. The optical signal relay device according to Claim 20 or 21, further comprising:

an optical signal storage element, temporarily storing an optical distributed from the optical signal distributor; and an optical feedback transmission path, feeding back the optical signal output from the optical signal storage element to the input side; and wherein

when the optical signal is an optical packet signal that is to be stored temporarily, the electronic controller makes a control optical signal, for converting the optical packet signal to a priorly set storage wavelength, be output, and

the optical distributor distributes the optical packet signal, after conversion to the storage wavelength, to the optical signal storage element and makes the optical packet signal be stored temporarily in the optical signal storage element.

23. The optical signal relay device according to Claim 22, wherein the optical signal storage element is equipped with a plurality of optical fibers, which are disposed in parallel and differ in optical propagation length in order to receive optical signals distributed by the optical distribution device,

the electronic controller makes a control optical signal, for

converting the optical packet signal to be stored temporarily to a priorly set storage wavelength in accordance with the storage time required of the optical packet signal, be output, and

the optical distributor distributes the optical packet signal, after conversion to the storage wavelength, to an optical fiber among the plurality of optical fibers of the optical signal storage element and temporarily stores the optical packet signal in the optical fiber.

24. The optical signal relay device according to Claim 20, wherein the all-optical controller comprises: an optical coupler, branching a portion of the first input light; a continuous light source, generating continuous light of the same wavelengths as the control light; an optical coupler, multiplexing the continuous light from the continuous light source with the portion of the first input light from the optical coupler; and a semiconductor optical amplifier, receiving the light from the optical coupler, outputting control light having the modulation signals contained in the first input light, and being of slower response speed than the semiconductor optical amplifier.

25. The optical signal relay device according to any of Claims 19 through 24, wherein when output light that are from the main optical signal amplifying triode unit are input, the optical distributor selectively distributes the output light, which have been input, to optical transmission paths, among the plurality of optical transmission paths, that correspond to the wavelengths of the control light.

26. The optical signal relay device according to any of Claims 19 through 25, wherein the optical distributor is an array waveguide grating type splitter, which comprises: a first slab waveguide,

connected to an input port; a second slab waveguide, connected to a plurality of output ports; and a plurality of array waveguides, disposed between the first slab waveguide and the second slab waveguide and differing in length; and distributes input light that has been input into the input port among the plurality of output ports according to the wavelengths of the input light.

27. An optical signal storage device, storing an optical signal input from an input optical transmission path and enabling taking out of the optical signal at an arbitrary time, comprising:

- a control light generator, generating control light for converting the optical signal input from the input optical transmission path to wavelengths, which correspond to the transmission destinations contained in the input signal and are the same as or different from that of the optical signal;

- a main optical signal amplifying triode unit, receiving the optical signal that has been input and the control light and converting the optical signal that has been input to optical signals of the wavelengths of the control light;

- an optical distributor, distributing the optical signals, output from the main optical signal amplifying triode unit, in accordance with the wavelengths of the optical signals;

- an optical buffer memory element, temporarily storing an optical signal of a storage wavelength that has been distributed by the optical distributor;

- an optical feedback transmission path, feeding back the optical signal output from the optical buffer memory element to the input optical transmission path to re-input the optical signal into the main optical signal amplifying triode unit; and

- an optical signal storage control means, making the control

light generator output control light for conversion of the optical signal, which is repeatedly circulated through the main optical signal amplifying triode unit, optical distributor, optical buffer memory element, and the optical feedback transmission path, to an output wavelength at the main optical signal amplifying triode unit.

28. The optical signal storage device according to Claim 27, further comprising an optical signal gain control means, controlling the optical signal, fed back by the optical feedback transmission path, or the control light supplied to the main optical signal amplifying triode unit in order to restrain the increase and decrease of the gain of the optical signal that is circulated.

29. The optical signal storage device according to Claim 28, wherein the main optical signal amplifying triode unit comprises: a first semiconductor optical amplifier, which performs conversion to a wavelength of a bias light and inversion of the optical signal; and a second semiconductor optical amplifier, which performs conversion to the wavelength of the control light and inversion of the optical signal that has been inverted by the first semiconductor optical amplifier; and

the optical signal gain control means controls the optical signal, fed back to the optical feedback transmission path, based on the increase or decrease of the gain of the bias light contained in the output light from the second semiconductor optical amplifier.

30. The optical signal storage device according to Claim 28 or 29, wherein the optical signal gain control means comprises: a first gain control optical amplifier, receiving the bias light and a gain control light, which is a continuous light of a wavelength that differs from that of the bias light, and outputs a gain control light, which decreases in gain in accompaniment with an increase

of the gain of the bias light; and a second gain control optical amplifier, receiving the output light from the first gain control optical amplifier and the optical signal, which is fed back by the optical feedback transmission path, and outputs an optical signal, which increases in gain in accompaniment with a decrease of the gain of the gain control light.

31. The optical signal storage device according to Claim 30, wherein either or each of the first gain control optical amplifier and second gain control optical amplifier is arranged from an optical fiber amplifier or an optical waveguide amplifier into which a rare earth element is doped.

32. The optical signal storage device according to Claim 28, wherein the optical signal gain control means comprises: an optical operational controller, which controls the gain of the control light supplied to the main optical signal amplifying triode unit based on the increase/decrease of the gain of the optical signal fed back by the optical feedback transmission path in order to maintain fixed the gain of the optical signal that is circulated.

33. The optical signal storage device according to any of Claims 27 through 30, further comprising:

- an electronic controller, controlling the control light generator;

- a photoelectric signal converter, converting the optical signal branched by the optic splitter into an electrical signal and supplying the electrical signal to the electronic controller; and

- an optical delay element, disposed at the downstream side of the optical splitter and delaying the optical signal that is to be input into the main optical signal amplifying triode unit upon

passage through optical splitter; and

wherein the electronic controller makes the control light, for conversion of the optical signal to the output wavelength, be generated from the control light generator in response to an output timing indicated by stored signal output information that is supplied from the exterior or is contained in the optical signal.

34. The optical signal storage device according to any of Claims 27 through 32, further comprising an all-optical operational controller, which makes the control light, for conversion of the optical signal to the output wavelength, be generated from the control light generator in response to an output timing indicated by stored signal output information that is supplied from the exterior or is contained in the optical signal.